

The Elements of Botany. By A. DE JUSSIEU. Translated by
J. H. WILSON, F.L.S. &c. Van Voorst.

The "Cours élémentaire" is so well known that it is unnecessary for us now to speak of the great merits it possesses; we have here merely to express an opinion on the manner in which Mr. Wilson has executed the task of translating into English. Some few points might be adverted to where there is room for improvement, but on the whole the translation is very well done, and exhibits more than the average amount of care and fidelity. With the help of the original woodcuts and the adoption of a similar page and type, the English version, which perhaps retains rather too much of the French idiom, has been made quite a reproduction of the original, and as such will prove of great utility to those who cannot use the French version with facility.

PROCEEDINGS OF LEARNED SOCIETIES.

ZOOLOGICAL SOCIETY.

May 23, 1848.—R. C. Griffith, Esq., in the Chair.

OBSERVATIONS RELATING TO SOME OF THE FORAMINA AT THE BASE OF THE SKULL IN MAMMALIA, AND ON THE CLASSIFICATION OF THE ORDER CARNIVORA. BY H. N. TURNER, JUN.

Of all those parts of an animal frame to which the zoologist may direct his search for characters truly indicative of the affinities of the species, or of the group to which it obviously belongs, there is perhaps none in which a greater number of such characters are presented at one view than in the lower surface of the skull. Here are seen,—not only the teeth, whose differences of structure always have, and always will be, made considerable use of in assigning characters to zoological divisions, in whatever way our opinions as to the value of the characters derived from these organs may be modified by further researches,—but also the form and development of the zygomatic arch, with the capacity of the temporal fossa, and the mode in which the jaw is articulated; the form and extent of the bony palate, with its pterygoid appendages, the situation of the occipital foramen, and the structure of the condyles to which the atlas articulates, and many other characters of greater or less apparent consequence, may in the under surface of the cranium be all distinguished at a glance.

Accordingly we find that such of our more modern naturalists whose endeavour has been to fix classification upon a truly philosophic basis, instead of resting satisfied with the arbitrary subdivisions formerly in use, have directed their observations particularly to this part, so that the more obvious characters which it affords have been well observed, and turned to very useful account in determining the extent and affinities of groups; but in some cases, where, from the very close alliance existing between the genera, the differences presented in this part are necessarily very minute, their importance in a zoological point of view has not as yet been recognized. As some of the characters of which I propose to avail myself in the

classification of the order Carnivora consist of peculiarities in respect to certain of the foramina at the base of the cranium, I may perhaps be permitted, although the foramina have already been to some extent studied by those who have entered minutely into the details of mammalian osteology, to point out some instances in other orders, where, in the course of such observations as my opportunities have permitted, I have noticed relationships between the peculiarities presented by the foramina and certain natural groups already established by well-marked characters.

For example, when we see that throughout the whole series of Marsupial Mammalia—an order which, notwithstanding the widely different modifications which its forms present, is marked by many striking peculiarities of structure which quite isolate it from all other members of the class—a number of minor peculiarities are equally constant, and therefore in any species equally indicative of that particular type of structure; and among these, that the internal carotid artery does not enter the cranial cavity, as in most mammalia, by a foramen in the tympanic bone, nor—as is the case in many, and might here be well expected, from the small development of the tympanic bone—through a fissure between that bone and the basi-sphenoid, but through a special foramen, which is pierced on the side of the basi-sphenoid bone, and enters the skull in an inward and forward direction,—we are surely justified in attaching some importance to this peculiarity in a zoological point of view, and in considering it just as characteristic of the Marsupial order as the articulation of the head to the atlas by a double condyle is of the Mammalian class itself.

The remarkable differences in general structure presented by the skull throughout the Rodent order, so carefully investigated and judiciously applied to its classification in the researches of my accomplished friend Mr. Waterhouse, render it quite unnecessary to descend to such minute and comparatively unimportant characters as those which the foramina may afford; and from the frequent imperfection of bony development in these usually small and rather lowly organized mammalia, we cannot expect to find the characters presented by the foramina of so strictly definite a nature as those I shall have to point out in animals of higher types of structure; but nevertheless, when due allowance is made for these occasional imperfections of development, we shall yet find, that although the characters of the foramina in this order are not sufficiently decided to be very serviceable to the zoologist, they present a certain general accordance throughout the groups, which in connection with the present subject may perhaps give them some degree of interest.

In this order, the canal, for which I here propose the name of alisphenoid canal, and which serves to protect the continuation of the external carotid artery during a part of its course, seems to be of nearly constant existence, although in many species of the *Hystrioidæ* it coalesces, through non-development of the separating lamina, with the fissure passing through between the walls of the pterygoid fossa into the orbit. The fissure alluded to, for which Mr. Waterhouse

suggested, though I am not aware that he has published, the name of interpterygoid canal, is a characteristic of this family. There is another remarkable canal which exists in I think I may say the greater number of the species in this order, and which I have not as yet noticed in any species of other orders: its posterior opening is near the foramen ovale, sometimes on the outside and sometimes on the inside of the cranium; it extends forwards a short and variable distance, then opens externally, and serves to transmit a nerve to the masticatory muscles: this canal, which is not unfrequently double, I will here, for convenience of reference, designate the external ali-sphenoid canal*.

The Hares present characters differing from the rest of the order, in the absence of the ali-sphenoid canal †, and in having a distinct canalis caroticus excavated in the tympanic bone; the external ali-sphenoid canal usually exists, and is double, but from imperfection of bony development is not always very clearly demonstrable.

The ali-sphenoid canal must be said to be of constant existence in the *Hystrioidæ* (as defined by Mr. Waterhouse), although, as I before observed, it often coalesces with the interpterygoid, through non-ossification of the lamina which separates them; for its outer wall is always distinct; and even in the Caviine subfamily, where the maxillary bone extends back to meet the temporal, the ali-sphenoid bone always lines the bridge thus formed, so that the canal no less deserves the name which I have ventured to propose for it. The external ali-sphenoid canal also exists in this family; it is not usually demonstrable in the *Caviina*, having apparently coalesced with the true ali-sphenoid; but in a large skull of the *Capybara* contained in the Society's collection it is very distinctly separated. In some of the Hystricine subfamily (*Sphiggurus*, *Erethizon*, *Chatomys*) this canal is double, and in such of them as have the true ali-sphenoid canal coalesced with the interpterygoid, the lower division of the external ali-sphenoid might perhaps be mistaken for it; but the true ali-sphenoid canal always opens anteriorly *within* the lamina which forms the external pterygoid process and the outer boundary of the coalesced foramina speno-orbitarium and rotundum, while both divisions of the *external* ali-sphenoid canal open on the outside of this lamina; in those species however which have the true ali-sphenoid canal separate, the homology is at once apparent.

Although the arrangement of foramina in the common Rat and

* This canal is alluded to by Cuvier (*Anatomie Comparée*, 2nd edition) in several cases; I will cite one of them:—"Dans le porc-épic commun . . . il y a dans l'aile pterygoïde externe deux canaux, l'un inférieure, s'ouvrant en arrière à la racine de cette aile, un autre supérieure, et s'ouvrant près du temporal. C'est le premier qui paraît être l'analogue du canal vidien." That is, of the canalis ali-sphenoideus, as I shall hereafter show that it is not the homologue of the vidian canal; the second alluded to by Cuvier is the canalis ali-sphenoideus externus.

† Cuvier also observes, "Dans les lièvres . . . le canal vidien (the ali-sphenoid) n'est qu'un trou dans l'aile pterygoïde externe," and his editors add, within brackets, "et que l'on distingue dans l'orbite tout près et en dehors du précédent." The hole alluded to, however, from being situated quite in the depth of the pterygoid fossa, is much more like the interpterygoid canal in the *Hystrioidæ*.

the common Squirrel appear very different from each other, there is in fact but little to distinguish, so far as these peculiarities are concerned, between the families to which they respectively belong. In the latter animal, and indeed throughout the family, we find the following arrangement: the foramen ovale is a large round hole, within the edge of which open the posterior orifices both of the true ali-sphenoid canal and the *canalis ali-sphenoideus externus*, and also of a canal which only penetrates the substance of the basi-sphenoid bone, and meets its fellow from the opposite side. The foramina *lacerum anterius* and *posterius* are each of small size; I cannot perceive any distinct *canalis caroticus*. In the Rat the *canalis ali-sphenoideus externus* does not exist, its place being marked by a rather indistinct groove in the bone; the true ali-sphenoid canal is present, and its posterior opening is some distance anterior to the foramen ovale; the foramen entering the substance of the basi-sphenoid also exists, but is situated some distance behind the foramen ovale; from the posterior corner of the external pterygoid process there is continued a little bridge of bone, which arches completely over the foramen ovale: there is no *canalis caroticus*, a groove only representing it. But in specimens that I have dissected for the purpose, I have noticed that the *external* carotid artery actually enters the cranium through a canal in the posterior part of the tympanic bone, from which it emerges above, and after passing within the cranium for a short distance, passes out again through the long fissure that separates the anterior side of the tympanic bone both from the ali-sphenoid and the squamous bones; it then passes through the little bridge that crosses the foramen ovale, and then through the ali-sphenoid canal, after which it, as usual, meets with the second branch of the fifth pair of nerves, and accompanies it through the infra-orbital foramen to the upper lip. But the chief differences here pointed out between the Rat and the Squirrel seem only to consist in the extension backwards, in the latter, of the ali-sphenoid canal to the foramen ovale, and the presence or absence of the lamina that encloses the *canalis ali-sphenoideus externus*. Some genera of Rats (as *Cricetus*, *Cricetomys*, *Hapalotis*, *Hydromys* and others) present in these respects the same characters as the Squirrels, in some of the larger species of which we even see a very slender arch of bone just before the foramen ovale. However, in all those genera of Rats alluded to, the fissure by which the external carotid artery emerges from the cranium is very apparent, and I have not perceived it to exist in any of the *Sciuridæ*.

In the Edentate order, which, though so limited in the number of species, is far from being so in the variety of its forms, the foramina present characters which will connect together those forms which other and more important characters show to be nearly allied. In the Armadillos the optic foramen is small and distinct; the foramen rotundum has coalesced with the foramen spheno-orbitarium; the foramen ovale is a distinct, roundish aperture: there is usually a distinct *canalis caroticus*, but in the *Dasypus sexcinctus* it is only enclosed at the anterior part; and in one specimen that I have seen,

that of one side only is completely enclosed: the foramen lacerum posterius is very small; there is a distinct foramen glenoideum. In the *Manis* the characters of the foramina are very similar, but there is no canalis caroticus.

In the *Orycteropus Capensis* the small optic foramen is placed back within the lamina enclosing the coalesced foramina speno-orbitarium and rotundum, so that in a side-view it is concealed: just before the foramen ovale is an opening into the substance of the bone: the foramen lacerum anterius extends all along the anterior and inner side of the bone of the ear; the foramen lacerum posterius is of a roundish oval form; the foramen condyloideum is very large: there is neither a distinct canalis caroticus nor a foramen glenoideum.

The Sloths have some peculiar characters of their own: in them the foramina opticum and speno-orbitarium are distinct within, but the orbito-sphenoid sends out a little process forming a canal, which serves as the external opening for both of them; the foramen rotundum is quite separate, opening at some distance below: in the *Bradypus tridactylus* it opens just at the point where the vertical lamina of the palatine bone joins the orbito-sphenoid; the foramen ovale is also very close to the junction with the pterygoid. There is a distinct canalis caroticus, but no foramen glenoideum; the foramen condyloideum is large and conspicuous.

It is in the Pachydermatous and Ruminant orders, however, that I am enabled to show the clearest indications of accordance between certain characters of the foramina and the groups into which these orders are divided. In the elaborate and highly-interesting paper read not long since by Professor Owen before the Geological Society, in which he suggested the admirably-chosen names 'Artiodactyla' and 'Perissodactyla' for the two subdivisions of the Ungulate Mammalia, it is much to be regretted that he has in no way alluded to the characters which the under surface of the skull presents; for they show three different types of structure, which, so far as those genera, of which the under surface of the skull is known, would indicate, appear very distinctly separable. Of these, two are included in the order Pachydermata, as usually adopted, while the third is that of the Ruminant. I am not at present prepared to offer any decided opinion as to the suggestion of Professor Owen, that the two orders ought to be united; and indeed that question forms no part of the present disquisition; but in pointing out the characters presented by the cranium in these three distinct types, I cannot but very much regret that I have not been able to meet with skulls of any of the fossil genera that afford the intermediate links by which Professor Owen proposes to unite the orders, in such a condition as to enable me to discriminate the characters of the basal portion of the cranium. Perhaps the absence of such specimens may in some measure account for the omission of any notice of these characters in the paper to which I have alluded.

In looking on the under surface of a Ruminant skull, the observer is at once struck with the great separation between the nidus of the last molar tooth and the walls of the canal of the posterior nares;

while in both the divisions of the Pachydermatous order the connection between the palatine and maxillary bones is continued quite to the posterior termination of the latter. In the Ruminant the canal of the posterior nares is of immense depth in the vertical direction, its walls extremely thin, the true pterygoid bones reduced to thin laminae lining the posterior part of the canal, and forming the hamular processes; and although in the Camel and Llama, the external and internal processes (of which the former belongs to the sphenoid, while the latter is the true pterygoid bone) being each well-developed at the tip, there is a considerable notch between them, the outer pterygoid entirely wants that lateral expansion which in animals having a pterygoid fossa forms its outer wall.

The occipital bone has usually its basal surface flat, marked with eminences, of which different ones are more or less developed in different genera. In the Sheep there is a salient one on each side, rendering the surface of the bone between them quite concave; while in the Camel, the Ox, and the Deer, it is another pair of tubercles that are most developed, being situated close to the condyles, the articulating surfaces of which approach each other more than in the Hogs*, and in the Deer and Camel are even continued on to the tubercles. The paroccipital processes also in Ruminants take their origin more towards the outside than in the Hogs, and the space between this process and the condyle is much more deeply excavated. Each of the three separate types of Ungulata before-mentioned has likewise its distinct form of articulation for the under jaw. That of the Ruminants is a slight convexity, shelving off into a nearly semi-circular concavity behind, thus admirably adapted for the rotatory grinding motion of the under jaw; this concavity is bounded behind by a ridge, which terminates within in a small process †.

The following characters are afforded by the foramina:—The foramen ovale is large, distinct and exposed, completely enclosed by the ali-sphenoid bone; there is no trace of an ali-sphenoid canal, nor of a distinct canalis caroticus, it being represented merely by a notch in the auditory bulla, having merged into the adjacent fissures. The foramen condyloideum occupies a rather concealed situation, especially in the Deer, where it is quite hidden by the laterally expanding anterior termination of the occipital condyle: the foramen glenoidem (so named in the second edition of the '*Leçons d'Anatomie Comparée*') exists in Ruminants.

The Hogs and allied genera, constituting the artiodactyle division of the Pachydermata, are constructed upon a second type, also marked by characters seen in the under surface of the skull. The palate is flat and solid, its level much below that of the base of the cranium, extending back quite as far as the extent of the molar series, which throughout its length is closely applied to the walls of the posterior nares; therefore the large notch so remarkable in the Ruminant does

* In the Camel they are absolutely in contact below.

† This process, which is placed more outwardly in the equine type of Pachydermata, is in the Rhinoceros much elongated, and even touches the paroccipital, enclosing the meatus auditorius between them.

not exist, and the pterygoid fossa is nearly in a line with the molar series. The occipital bone presents characters strikingly different from that of the Ruminant; its surface is flat beneath, with a ridge along the middle; the condyles are rather distant from each other, their articulating surfaces terminating very abruptly in front; the paroccipital processes are straight, much prolonged in the genera *Sus* and *Babirussa*, placed less laterally than in either the Ruminants or the other division of the Pachydermata, and from each is continued inwards a ridge on about the same level with the base of the occipital bone, and on or near its summit the foramen condyloideum is seen. The space is short between the posterior nares and the auditory bullæ, and the origin of the zygomatic process, with its articulating surface, is so much pushed back, that a line drawn across from one to the other would pass right through the bases of the large udder-shaped processes of the tympanic bone; and the pterygoid processes of the sphenoid have so much lateral expansion, that when the true pterygoid bones have sufficient development to form the inner walls, the fossæ are very distinctly marked. For the articulation of the lower jaw there is a transversely elongated surface, concave transversely, slightly convex in the antero-posterior direction, which serves alone as a fulcrum for the movements of the jaw, since the space behind it is rugged and does not present the characters of an articulating surface.

But the group at present under consideration seems clearly to admit of separation into two distinct subdivisions, to the first of which, including the genera *Sus*, *Babirussa* and *Phascochærus*, the foregoing observations are intended more particularly to apply. Of the second, the Peccary and the Hippopotamus present us living examples, and to it the greater number of the extinct genera of artiodactyle Pachydermata must belong, if the difference which the two subdivisions present in the structure of the molar teeth be found constantly to accompany those of the skull*.

As so few genera of this second subdivision of the artiodactyle Pachydermata have presented their entire cranium for our examination, it will be better to content ourselves with pointing out the characters in which that of the Peccary, a convenient standard for comparison, differs from the genuine Hogs.

In this animal the pterygoid bones and processes are pushed nearer the middle, narrowing the aperture of the posterior nares; and although the adult Peccary shows no fissure between the alveoli of the

* In the very brief notice communicated to the Society last year by Mr. Hodgson, of a diminutive species of Indian Hog, on which he founds the genus "*Porcula*," it is much to be regretted, that while endeavouring to establish the zoological position of the genus between the Hogs and the Peccary, and mentioning, as approximating it to the latter, some very trivial external characters, together with the number of molars, which being six in each series, cannot indicate such an affinity, since the *Babirussa*, a true Hog, has (in the adult state at least) only five, he has omitted to acquaint us with the structure of those molars, which it might have been expected that a naturalist would have made the subject of particular observation, and which would very probably have decided the point of affinity in question.

molar series and the walls of the nasal cavity, yet in a rather young skull of *Dicotyles labiatus*, where the penultimate molar has not quite risen into its place, and the last remains still imbedded in its socket, there is on each side a narrow fissure between the posteriorly projecting nidus and the pterygoid appendages; but this character can scarcely be reckoned among some others which do seem to approximate the Peccary to the Ruminants, since the fissure is great even in the adult Ruminant, and in no adult member of the Pachydermatous order does the termination of the molar series extend back so far as to reach the anterior termination of the pterygoid appendage.

It is in the occipital bone that the Peccary departs most from the character usual in the Hog-tribe, and approaches to that structure which is presented by the Ruminants, and by the other large group of Pachydermata. The origin of the paroccipital processes and the absence of the ridges extending inwards from their bases, together with the position of the foramen condyloideum, approximate the genus to the last-mentioned groups; but the processes themselves, although they are short, approach nearer in form to those of the Hogs. The lateral expansion of the pterygoid processes, although still considerable in *Dicotyles labiatus*, is much reduced in the Tajaçu. The glenoid cavity is not pushed back to the same extent as in the Hogs, and its level is relatively much lower than either in them or in the Ruminants; so that a line drawn through the posterior terminations of the articulating surfaces would pass through the auditory bullæ near their lower surfaces; and the structure of the glenoid cavity itself is quite distinct, somewhat resembling that so characteristic of the order Carnivora. It is an oblong surface, lengthened in a direction slanting from behind forwards and outwards, and is concave in the antero-posterior direction. The Hippopotamus shows itself to be closely allied in the structure of the occipital bone and of the glenoid cavity: the pterygoid bone is not sufficiently developed to form the inner wall of a fossa*.

In both divisions of the artiodactyle Pachydermata the foramen ovale is not completed by the ali-sphenoid behind, but truly merits the name of a "foramen lacerum": there is no trace whatever of the ali-sphenoid canal, nor of the canalis caroticus, nor, in the true Hogs, of the foramen glenoideum; this however exists, but is very small in the Peccary, in which also the position of the foramen condyloideum differs from that of the true Hogs in a degree corresponding to the altered structure of the occipital bone.

The third great type of Ungulated Mammalia (the *Perissodactyla* of Professor Owen) is also marked as distinctly by the conformation of the base of the skull, as by that characteristic structure of the tarsus which enables the palæontologist, on looking only at an astragalus, to recognize "the armed Rhinoceros" as readily as if the animal complete were presented to his view. The skulls of the Horse, the Tapir, and the Rhinoceros, when we look on their under surfaces,

* In an excellent skull of this animal contained in the Society's collection, the lacrymal bone forms within the orbit a considerable osseous bulla, having thin parietes, and apparently destined for the protection of the lacrymal sac.

show at one glance so striking a similarity of plan, that if we can but divest ourselves of prejudged notions, which the great contrast in external form may have imparted, we cannot doubt their close alliance; and the little Hyrax, the only other living genus of this family, when we make allowance for those differences of proportion invariably existing between species organized upon one plan, and differing much in size, will also be found closely to resemble its more gigantic relatives. In this group the bony palate is curtailed in length, its level not much below that of the base of the cranium, and the size of the posterior nasal orifice made up chiefly by its great increase of length in the antero-posterior direction. Here also there is no fissure between the wide-spreading walls of the nasal canal and the nidus of the last molar tooth. The form of the auditory bulla presents a nearer approach to the Ruminant than the Hog, as also does the occipital bone, especially in the form and relative position of its condyles and paroccipital processes; but the under surface of its basal portion is flat, and very convex in the transverse section; the lower jaw articulates on a fulcrum similar to that described in the true Hogs, but posteriorly is a smooth concave surface, which terminates behind in a characteristic salient process. Among the characters of the foramina this division is well-distinguished from either of the others by the presence of the ali-sphenoid canal, which exists in all the living genera, and, as already pointed out, is wanting both in the Ruminants and in the Hog-tribe*.

This canal is also present in the Elephant and Mastodon, an aberrant division of the order, also possessing toes in uneven number, and still further characterized by being the only members of the Ungulate division that have a distinct *canalis caroticus*, and by their wanting the *foramen condyloideum*.

A sufficient number of examples have now I think been adduced, to show, that although the instances may be few in which a group could be isolated by characters drawn from the foramina alone, yet in most cases they will be found to be of some assistance in marking the limits of closely-allied divisions; and even in those cases which I have brought forward, it is far from my intention to advocate that

* Since this paper was communicated to the Society, it has struck me that the similarity of structure (which must have been observed by every naturalist who has given attention to the subject of dentition) existing between the premolars and true molars in the members of the Perissodactyle division, may prove an important addition to the zoological characters of that group. This must of course depend upon the confirmation, by further researches, of the idea, that in most Mammalia a *premolar* represents, in the homologies of its component parts, only the *half* of a *true molar*; but there can be no doubt that in the group alluded to the premolars each represent the *whole* of a true molar, for the resemblance in most cases is very striking. Among all the genera, the extinct *Lophiodon* is that which looks most like an exception: unfortunately, I have never had access to any specimens of this genus; but so far as I can judge of it by the figures published, I should be inclined to the belief that further researches will show, that notwithstanding the apparent dissimilarity, the premolars of the *Lophiodon*, as well as those of the other members of the group, each represent the whole of a true molar; and that in the other divisions of the Ungulata, as well as in most members of the class, the half only of a true molar is typified.

any use need be made of such characters as these, when the groups can be so well established upon characters more obvious and important in their nature.

We frequently find groups which, though very extended as to the number of species they contain, are much more limited in respect to the varieties of structure they present than other groups apparently of equal rank containing a much smaller number of species. Such groups are of course always the most easy to isolate, but the most difficult to subdivide: it is in these that we find the most confusion existing, and the greatest variety of opinion among naturalists as to the manner in which their subdivision should be effected. Excepting in the highest divisions, it is but of late years that naturalists have at all appreciated the distinction between what are usually termed "essential" and "adaptive" characters, of the former of which, as we descend to the lower groups, not only is the existence, but also the importance, much less easily recognized.

The base of the cranium, as I before observed, is, from its having less connexion than most parts of the bony framework with the peculiar wants of the species, by far the most rich in such characters; among those which the foramina may afford, I must here dwell rather particularly on the evidences of affinity afforded by the presence or absence of the ali-sphenoid canal, and also explain my reasons for assigning it a new name. As will appear from the observations I have brought forward, it exists throughout the Rodentia, excepting the aberrant family of Hares; it is wanting in the Marsupials and Edentata; and among the Ungulate division, including the Ruminants and Pachydermata, the Artiodactyle division, including the Ruminants and those Pachyderms which have the toes in even number, is constantly characterized by its absence; while in the Perissodactyla it is as constantly present. In the first edition of the '*Leçons d'Anatomie Comparée*,' the illustrious author only alludes to this canal in a very vague manner; and in the more recently published edition, in which the osteology of the cranium is much more fully elaborated, it is spoken of everywhere as being the vidian canal,—the existence of a vidian canal being denied in those animals which do not happen to possess it. From the time when I commenced the series of observations of which the present is an attempt to sum up the results, I always felt inclined to the belief that the canal in question did not correspond in situation to the vidian canal as known in Human Anatomy, since this canal commences just at the root of the internal pterygoid process, while that pointed out as such in the work alluded to is quite on the outside of the homologue of the outer one. Among the rest, the Monkeys are spoken of as wanting the vidian canal; but on removing from the skull of a small monkey in my collection the whole of the posterior portion, and the temporal bones with auditory bullæ, the posterior apertures of the vidian canals became very apparent, and fine bristles passed readily through them into the orbits; and in other skulls belonging to the Quadrumanous order, provided that those portions of the upper maxillary bone which originally constitute the alveoli of the hinder molars do not rise high enough to

conceal the vidian canals, and that the skull be sufficiently well-cleaned, their anterior openings can usually be seen without difficulty. I have succeeded in tracing it throughout the Carnivora, Ruminantia, Pachydermata* and Edentata; it is always, at least in its posterior portion, wholly or partly enclosed by the true pterygoid bone, which constitutes the inner wall of the pterygoid fossa, so that the term "pterygoid canal," which has been applied to it in Human Anatomy synonymously with that of "vidian," is very correctly applicable. Its anterior opening is always just beneath that of the foramen spheeno-orbitarium, so that the issuing nerve can communicate readily with the second branch of the fifth pair, soon after its exit through the foramen rotundum. It may be further remarked, that the opening of the true vidian canal is always on the inner side of the foramen rotundum, while that of the ali-sphenoid canal is always on its outside, and usually covers and conceals it. However, I think I have removed all doubt by the dissection of a sheep's head, in which I have traced the vidian nerve from its junction with that of the seventh pair to the foramen in question; the course of the nerve is usually longer and more tortuous in the lower animals than in Man.

I have also perceived in some skulls belonging to the Marsupial order, a canal which from its situation seems to be the vidian; in the Rodent order, a distinct vidian canal seems rendered needless by the constant existence of a fissure communicating between the posterior nares and the apex of the orbit, and in some skulls I can even see faint indications of a groove extending from the foramen lacerum anterius round the inner side of the base of the pterygoid bone to the margin of the fissure; but I would not at present venture to deny the existence of a vidian canal in any species, considering that, with the exception of some Edentata, as the Armadilloes, in which its calibre is proportionally very large, it is extremely difficult to perceive in any small-sized animal.

It now becomes my task to place in an intelligible light, the observations on the crania of the Carnivora, which have led me to believe that the classification of this order may be set upon a firmer basis than that afforded by the characters generally made use of. In the course of the present disquisition, I must be allowed to consider this order exclusively of the Insectivora and Marsupials, which are by many naturalists included, the former indeed most usually, as part of the order in question. When the order Carnivora is thus circumscribed, we find it to consist of a very great number of species, being exceeded in that respect among the Mammalian class only by the Rodentia; and notwithstanding the striking difference of ex-

* In the justly celebrated work by Mr. Swan, on the Comparative Anatomy of the Nervous System, it is said that the Common Hog does not possess a distinct vidian nerve running in a bony canal; and certainly, I have not very clearly succeeded in demonstrating the canal in that species, but a skull in my collection of the *Sus Indicus* shows it very well; in the Babirussa, the anterior and posterior portions of the canal each open into the sphenoidal sinus, which has great extent in that animal.

ternal appearance that may be noticed among its members, so that we should anticipate but little difficulty in subdividing the order into a number of natural groups, the confusion, and differences of opinion that have existed, not only as to the manner in which the order should be divided, but also as to the position which certain forms should occupy, show sufficiently that the task is by no means an easy one; and when the structure of the different members of the order is investigated, and those forms are known to us by which the most strikingly different genera are blended one into another, it becomes difficult to draw the lines of separation, and still more to fix the characters by which the groups can with accuracy be distinguished from each other. In the present state of zoological science, it seems scarcely worth while to allude to the distinction of plantigrade and digitigrade, which though due to no less an authority than Cuvier, can hardly be said to possess any claims to the title of a philosophic distinction. Indeed the former of these divisions, if the character be fully insisted on, will include a very incongruous assemblage of forms.

It is upon the differences of the teeth that the subdivision of this order has been made chiefly to depend; but, although it does so happen that in most cases the affinities of a species may be truly predicated by the inspection of these organs, there are some in which naturalists have been led into error by too rigidly depending on them; it must be recollected that, especially in an order like this, where we find among the different species, every gradation between a purely carnivorous diet, and the capability of subsisting entirely on vegetables, the teeth, by the various degrees to which the different cusps are developed, and also by the point at which the normal development of true molars from behind may be arrested, present a very great variety in the amount of tubercular surfaces, or of trenchant edges, to suit the regimen of the species, without any necessary connection with its true affinities. For instance, the remarkable variation in the number of true molars presented by the different genera of the Dog-tribe is known to naturalists; and my own collection possesses the skull of a small dog in which, such is the arrest of development resulting from the shortening of the jaws, that although the individual was very old, it had never developed more than one true molar above and two below, or one behind the carnassial tooth in each jaw, being one less than is usual in the species.

If we except the aberrant family of Seals, we find that this order does not present so many of those very striking extremes of adaptive modification as are to be met with in some others, the generally lithe and active form prevailing through the order rendering a very moderate amount of adaptive modification necessary to fit the animal for almost any situation and mode of life, and from this cause it also happens that since the fallacious nature of the old division into plantigrade and digitigrade has been generally perceived, the classifications of this order most usually adopted by naturalists have approached much nearer to those natural divisions, which the essential

characters point out, than in many other orders; but at the same time, the general similarity of structure, to which I have before alluded, pervading the different modifications of form, has rendered it more than usually difficult to find characters truly essential, and independent of adaptive differences, on which to found truly natural subdivisions. These characters, when found in such an order as the Carnivora, we may fairly presuppose to be minute, and such of them as I have been able to discover, and which I have found to be constant so far as my opportunities of observation have extended, it is my object here to point out; with regard to the foramina, there is one which seems to be very characteristic of the order itself, since even in the true Bears, in which it does not exist as a canal, it is represented by a very well-marked groove. In other Carnivora it consists of a canal situated on the inner surface of the exoccipital bone usually running from before backwards and downwards; it gives passage to a vein; and if a special name should at any time be deemed requisite, perhaps that of exoccipital canal may be found suitable. The characters of which I purpose to make more or less use in the subdivision of the order, are the structure of the pterygoid bones and processes, the presence or absence of the ali-sphenoid canal, the form of the auditory bulla, and the course of the internal carotid artery through its canal, the structure of the mastoid and paroccipital processes, the situation of the foramen condyloideum, and to some extent, the structure of the lower jaw. It is by the fortunate circumstance of possessing in my own collection, crania representing all the leading divisions of the order, that I have been enabled, in the first instance, to remark the differences presented by the characters alluded to; but excepting a few genera, which I have been enabled to examine in the museums of the College of Surgeons and of this Society, it is only in the excellent series of skulls contained in our National Museum that I have been able to collect evidences of their constancy. Such being the limits of my opportunities of observation, it cannot be expected that I should give an opinion as to the precise zoological station of every one of the numerous genera; I will therefore take as a standard system the classification made use of in the List of Mammalia published by Mr. Gray, by order of the Trustees, since in the principal divisions it accords pretty nearly with my own ideas; simply pointing out where I find any genus whose cranium I have examined which I think requires to be altered in its position, and at the same time assigning to the divisions characters of my own, and expressing my opinion as to their rank.

Although in that classification the Bears are placed near the termination of the series, yet I believe it to be most usual to reverse the order and to begin with them; therefore I will first point out the characters which they present, and in so doing will confine myself to the genus *Ursus*, the subfamily *Ursina* of Mr. Gray. We here find no trace of a pterygoid fossa, the outer pterygoid process being closely pressed against the inner one, or true pterygoid bone, and sending off a strong lamina of bone to enclose the ali-sphenoid

canal, and, almost from its apex, a strong column of bone which runs backwards extending behind the foramen ovale, which it quite converts into a canal.

The auditory bulla, although, from the rough flat surface which it presents, it scarcely merits that name, yet may be perceived to show the same essential character as in the Weasels, which is, that it rises suddenly on the inner side at once to its greatest prominence, and is then flattened off towards the meatus, which is rather prolonged. The course of the internal carotid artery, as indicated by the canal excavated for it in the bone, is as follows:—it enters by a true *canalis caroticus* excavated in the bone of the ear, commencing quite behind, in the same fissure in which open the foramen jugulare and the aperture through which the *nervus vagus* issues from the skull, and extending forwards in a slightly arched direction again emerges anteriorly, and curving round, enters the cranium in a backward direction through a round foramen between the sphenoid bone and that of the ear, close to the aperture from which the Eustachian tube would issue, and corresponding to the foramen *lacerum anterius*; there is a distinct foramen *glenoideum*, although opening rather more inwardly than usual; the mastoid and paroccipital processes are both largely developed, and, owing to the very slight projection of the auditory bulla, stand out very distinct and prominent; the foramen *condyloideum anterius* occupies an exposed situation; the foramen *condyloideum posterius* I have never seen in any skull but the human, and there it is said to be sometimes wanting. The characters presented by the lower jaw in the Bears are essentially those most usual, though not quite constant, among the Weasel group; the angular process is pushed up very near to the condyle, and much flattened beneath; the form of the coronoid process is somewhat that of the true Weasels, but owing to the jaws being in the Bear more pushed forwards relatively to the situation of the cranial cavity than in the Weasels, this process is more pushed backward to meet the temporal muscle, which is spread over the sides of the cranium. With regard to the little process projecting beneath and anterior to the angle of the jaw, it is a mere superaddition, which appears again in the *Cercoleptes caudivolvulus* among the subursine group, and also in the *Otocyon Lalandii* and the *Nyctereutes procyonoides* among the Dogs, in these having the form of a large vertical lamina, projecting from the lower surface of the jaw; it is also seen like a second angular process in the Seal, so that I should not feel inclined to assign to it more than a generic value.

The small group of plantigrade Carnivora known to naturalists as the "Subursine group," I will reserve for consideration by and by, and proceed to characterize the Weasel group, the subfamily *Mustelina* of Mr. Gray.

In this group the pterygoid appendages very seldom manifest any tendency to form a fossa, although in many species the outer surface is rough and marked with ridges for muscular attachment; from behind is continued most usually a ridge which runs backwards and

outwards along the lower and posterior margin of the foramen ovale. This group is constantly marked by the entire absence of the ali-sphenoid canal. In the remaining characters this group presents no essential difference from the Bears; the commencement of the canalis caroticus is usually near the middle of the inner side of the auditory bullæ, and anteriorly the vessel does not again quite reach the outside of the cranium, simply showing itself at the point where it doubles, through the cartilage covering the foramen lacerum anterius. The characteristic form of the auditory bulla has been alluded to, and may be traced through the different modifications which it presents; these mostly depend simply on the size of the species, it being much more swollen in the smaller ones, and in the small species of true Weasel much elongated: the mastoid and paroccipital processes also are developed in relation to the dimensions of the species, or even the age of the individual; in the smallest species they have scarcely any projection, while in the larger ones they show the same essential structure as in the Bears, and different from that to be described in other groups. The peculiarities usually exhibited in this group by the lower jaw deserve some mention, even though not sufficiently constant to characterize the group, because some similar characters are seen in certain genera of the Viverrine section, which also show some approach to the Weasels in the characters of the base of the cranium, and therefore seem to be entitled in their own group to the place nearest the adjoining one. The characters in question are, that the coronoid process is rather more upright, and has less curvature than usual in the order, and the angular process is placed closer to the condyle, and is flattened beneath. The straightness of the lower margin of the jaw, alluded to by Mr. Waterhouse in a short communication published a few years ago in the Proceedings of the Society, I will consider by and by.

In the *Viverrine* group there is always a distinct indication of a true pterygoid fossa; the ridge by which it is bounded externally is, in the true Civets, cut off suddenly behind: in the *Paradoxuri* and allied genera it extends further, being blended with the walls of the ali-sphenoid canal, and in some species terminating laterally in a minute process. In the *Herpestine* genera, which are those most approaching to the Weasels, the true pterygoid bones are more extended backwards (which is most usually the case in that group, and also in the Bears), and the outer margin of the fossa is very suddenly cut off, as in the true Civets. With very few exceptions, the ali-sphenoid canal is present in this group: in the second edition of the 'Leçons d'Anatomie Comparée,' the *Genets* are spoken of as wanting it; it exists however in the skulls that I have seen; the only exceptions that I have as yet met with are in the skulls of the *Rasse* (*Viverra malaccensis*) and of the small species of *Galictis*, recently described by Mr. Gray. In all the other characters, however, these crania indicate clearly the natural affinities. Had these exceptions been of the opposite kind, that is, had the ali-sphenoid canal been present in some species of a group in which it is usually absent, they might have been serious obstacles to the use of this character; but

since they seem to be merely instances of non-development of the bony lamina which should enclose the canal, I think we need not deprive ourselves of the assistance the character affords in the discrimination of groups; and further, I believe it will be found that by taking the aggregate of the characters I am here attempting to describe, the true affinities of any member of the order may without much difficulty be ascertained. The foramen glenoideum, when existing in this family, is of very small dimensions; the auditory bulla has very distinctly the appearance of being divided into two portions, of which the posterior is much the larger, and elongated in form: the more anterior division, which encloses the meatus auditorius externus, is much smaller, and partly overlapped by the other. In *Herpestes* and the genera allied to it the separation is rather less distinct, and the general form of the bulla partakes a little of that of the Weasels. The canalis caroticus is most frequently represented simply by a groove in the inner side of the auditory bulla, to give protection to the artery before it enters the cranium by the foramen lacerum anterius; but in most of the Herpestine genera it is protected by a closed canal, as in the Weasels. These genera, however, have a slight peculiarity of their own in respect to the entrance of the internal carotid artery, and that is, that after emerging from its canal it runs exposed for a short distance before finally entering the cranium. One of the most striking of the essential characters in this family is the structure of the paroccipital process; it is spread out, widened, and closely applied to the posterior surface of the auditory bulla, and the foramen condyloideum is by this means more or less concealed within the aperture of the foramen jugulare: these characters are very distinct in the Civets and Paradoxuri; in the Herpestine genera they are manifested a little less in degree, and the mastoid process is a little more extended, also spread over the auditory bulla, and blended with the paroccipital, so that the bony plate clothing, as it were, the posterior part of the bulla, has the appearance of being pushed a little towards the side.

The characters of the lower jaw, I before remarked, although not sufficiently constant in all cases to separate the groups, sometimes show interesting marks of affinity. In most of the genera of this group the coronoid process curves gently backwards as it rises, which is also its character in the Dogs, the Cats, the subursine group, and even in a few of the Weasels; but in the *Herpestes*, of whose approximation to the Weasels I have already mentioned so many indications, it presents that form of the coronoid process which characterizes most of the members of that group; and the angular process, although it is a salient process, as usual among the Civets, instead of being pushed up towards the condyle, yet shows that flatness on its lower margin which is more distinctly manifested in the Weasels and Bears than in any other sections of the order. The lower outline of the jaw has considerable curvature, both in *Viverra* and *Herpestes*.

Being of opinion that of the two remaining groups, the *Cats* approach the more nearly to the Civets, I will point out their characters

next. In them we still see more or less clearly the indication of a pterygoid fossa, but there is never any trace whatever of the ali-sphenoid canal, nor of the foramen glenoideum. The auditory bulla is always full and round, even in the largest species, in which however, as may be expected, it is proportionally less in size: in some species slight traces may still be discerned of the separation noticed in the *Viverræ*; the canalis caroticus is very minute: in this group the internal carotid artery itself is very small; the canal commences towards the posterior part of the auditory bulla, and never again appears at the outside, the foramen lacerum anterius being quite wanting. The characters of the paroccipital process are precisely those of *Viverra*, but its extent is much less, and the mastoid is rather more developed; the foramen condyloideum is concealed, just as in the Civets.

In a brief communication published by Mr. Gray in the 'Annals and Magazine of Natural History,' in which he describes a new genus of Dogs under the name *Cynalicus*, he very justly remarks, "the tubercular grinders are very variable in this tribe." I will now endeavour to point out some characters that can rather more safely be depended on. The pterygoid appendages have usually a deeper projection than in most other members of the order, and though marked with ridges on the outer side, these are scarcely sufficiently extended to form a fossa: the ali-sphenoid canal is a constant characteristic of the tribe; to this I have seen no exceptions, and should consider such a non-development as we have seen occasionally to occur in some of the smaller and more delicately constructed Civets less likely to happen among the Dog-tribe. The foramen glenoideum is always present and of large size. The auditory bulla is rather similar to that of the Cats, but usually a little flatter and not divided, and, like that of the Cats, is a little excavated towards the hinder and inner part, to form a considerable foramen lacerum posterius, in which open not only the foramina for the jugular vein and the nervus vagus, but the commencement of the canalis caroticus, which is of considerable size, and takes a course precisely similar to that of the Bear. The mastoid process is but moderately developed, but the paroccipital is very characteristic; its anterior edge is applied to the auditory bulla, but instead of being at all spread out, the process is laterally compressed and very salient, both in the vertical and backward direction. The foramen condyloideum occupies a very exposed situation, being upon the middle of a flat ridge which extends between the basi-occipital and the paroccipital process.

With the addition of the *Phocidæ* or Seal-tribe, the divisions which I have here attempted to characterize will correspond exactly to the six families proposed by Mr. Waterhouse in the paper before alluded to. It may however be very fairly questioned, whether a group whose members are so closely connected among themselves, and differ so little in essential characters, will justly admit of being divided into six sections, of so high a rank as the term 'family' is usually understood to imply. Mr. Gray, on the other hand, makes use of only two families, the *Felidæ* and the *Ursidæ*, including among the latter,

besides the true Bears, only the genera *Procyon*, *Nasua*, *Cercoleptes*, and *Ailurus*. I must confess that I cannot concur with him in including the subfamily *Mustelina* among the feline family, and at the same time separating the Bears from them as a separate family; for the course of my observations has convinced me that the Weasels are decidedly more closely allied to the Bears than to any other members of the order. Numerous genera have at various times been one after another abstracted from the Bear-tribe, and added to that of the Weasels, until at length only the four that I have mentioned have remained associated with the Bears. Some remarks in Mr. Waterhouse's paper seem to imply considerable affinity between the Weasels and the Cats. He observes, "The Cats appear to bear the same relation to the *Mustelidæ* as the Dogs to the *Viverridæ*." This may be, but I should not consider that relation a very close one. He alludes particularly to the straightness of the lower jaw as a common character of the two groups: in the first place, I would remark, that this character is by no means constant among the Weasels; and secondly, that it is merely a circumstance of form, resulting from other adaptive modifications of the form of the entire cranium, such as the relative length of the jaws, and the development, both in size and number, of the molar teeth. As the posterior termination of the molar series is always on a rather lower level than the glenoid cavity, and as the line of the dental series inclines regularly upwards and forwards, it follows, that for the incisors of the lower jaw to close with those of the upper, the lower jaw must be curved in proportion as the jaws are lengthened.

Among the characters which I have pointed out in the base of the cranium, it will be seen that the only tangible distinction between the Bears and the Weasels is the presence of the ali-sphenoid canal in the former, and its constant absence in the latter. Much as I have insisted upon the importance of this character as assisting to distinguish groups, I do not consider it sufficient alone to entitle the groups which it separates to the rank of *families*; neither am I prepared to admit the difference of the teeth sufficient for that purpose, these being, as I before observed, merely adaptive modifications. In the true Bears the number of true molars is on each side *two* above, and *three*, the full normal number, below. In the Weasels it is only *one* above and *two* below. In the subursine group, to which I must add the *Bassaridæ* of North America, it is *two* above and *two* below; and among these it is only the *Ailurus fulgens*, an Indian species, which possesses the ali-sphenoid canal; while the other four genera, namely *Procyon*, *Nasua*, *Cercoleptes*, and *Bassaridæ*, all American forms, agree among themselves in possessing the general characters common to the Bears and the Weasels, and in having no ali-sphenoid canal, and two true molars on each side in each jaw. The *Bassaridæ* has most usually been placed among the Viverine section, in which it also appears in the list published by Mr. Gray; but doubts have at various times been entertained as to that being its true station. Mr. Waterhouse remarks, in a note appended to the paper from which I have before quoted, "From an examination

of the external characters of *Bassaris astuta*, it appears to me that it belongs to this (the subursine) group;" and Mr. Blyth, in the translation of Cuvier's Animal Kingdom, mentions the *Bassaris* immediately after the *Cercoleptes*, and in a note very justly observes, "Strong presumptive evidence that the Basset (*Bassaris*) does not appertain to the Viverrine group is afforded by the restriction of the geographic range of the latter to the eastern hemisphere in every other instance. The presence or absence of a cæcum would decide the question." I am not aware whether this last-mentioned point has ever been ascertained, but from the characters presented by the cranium, I do not feel the slightest hesitation in referring this animal to the subursine group. It is true that the teeth have some resemblance to those of the *Viverræ*, but this only results from the greater or less development of different cusps, being an adaptation to a more carnivorous diet. The bony palate terminates more anteriorly than is usual in the Weasels, but this circumstance only depends upon the greater or less extension of a bony lamina, and I think is of but little moment: the pterygoid appendages are rather feebly developed.

If then we constitute the Bears and Weasels one family, *Ursidæ*, which I think the essential characters, however small they may appear, will readily warrant us in doing, we can then avail ourselves of the ali-sphenoid canal and the adaptive modifications of dentition to subdivide it into four subfamilies, namely *Ursina*, including only the true Bears, and characterized by the presence of the ali-sphenoid canal, and of two true molars on each side above and three below; the very remarkable genus *Ailurus*, of India, will of itself constitute a second subfamily *Ailurina*, having also the ali-sphenoid canal, but only two true molars below. In the third subfamily, *Procyonina*, I would include *Procyon*, *Nasua*, *Cercoleptes*, and *Bassaris*, an entirely American group, distinguished by the absence of the ali-sphenoid canal and the same number of true molars as *Ailurus*; and lastly, the extensive group of *Mustelina*, characterized also by the absence of the ali-sphenoid canal, and having only one true molar on each side above and two below.

Of the remaining groups, I have already expressed my opinion that the Cats and the Civets are the most nearly allied to each other. Among the characters which I have assigned to them will be found differences by which they may be distinguished from each other; but in the most remarkable and the greatest number of characters they differ chiefly in degree. To each of these has been referred in turn the group of Hyænas, usually considered as allied to the Cats; but Mr. Waterhouse urges that the *Viverræ* have the stronger claim to this aberrant genus. From the characters of the cranium, I should consider it as rather more approaching to the Cats. In all skulls of the Hyæna that I have seen, the ali-sphenoid canal is wanting, although in the second edition of Cuvier's 'Leçons d'Anatomie Comparée' it is affirmed that this canal (there called the vidian canal) is present, and that the author possessed a skull in which it existed on one side but not on the other. The roundness and want of division of the auditory bulla and the minuteness of the canalis caroticus approximate the Hyæna

to the Cats; in all the characters common to the Cats and Civets the Hyænas also agree. However, if these three groups be united, as I think would be justified by the characters, the difficulty in a great measure will be overcome. Three subfamilies will then constitute the family *Felidæ*; the *Felina* are characterized by the absence of the ali-sphenoid canal, the very minute size of the canalis caroticus, the absence of the foramen glenoideum, the auditory bulla having but little or no trace of division, and the molar series consisting of only three premolars and one true molar on each side above, and two premolars, with one true molar, below. The next subfamily, *Hyænina*, presents, as I have just before pointed out, the same cranial characters as the Cats, but it differs, as is well known, in the dentition. The largest subfamily of the *Felidæ*, the *Viverrina*, possess in general the ali-sphenoid canal, and sometimes a minute foramen glenoideum; the auditory bulla is more or less distinctly divided into two portions; the canalis caroticus is of average dimensions, although not always completely enclosed, and is placed towards the anterior part of the bulla, and the artery, after having passed through the canal, shows itself externally before finally entering the cranium: the dentition is on each side usually four premolars and two true molars, both above and below. The very singular genus *Proteles* has the cranial characters common to the Cats and Hyænas: from the dentition, so singularly modified by arrest of development, but little evidence of zoological affinity can be adduced; I should therefore be rather inclined to consider it a modified Hyæna, since in the external characters it so closely resembles the animals of that genus.

The Dogs, or the subfamily *Canina* of Mr. Gray, remain, and I think must constitute a separate family *Canidæ*; they all agree precisely in those cranial characters which I have pointed out, and notwithstanding the variation in the number of the true molars, do not seem to admit of division into subfamilies. It is rather remarkable that in the different genera of this family we find precisely the same variation in the number of the true molars as in the subfamilies of the *Ursidæ*; as, setting aside the genus *Otocyon*, in which they are developed, we may almost say, beyond their normal number, there are *two* above and *three* below in the genera *Canis*, *Vulpes*, *Nyctereutes*, and *Lycaon*, as in the *Ursina*, *two* above and *two* below in the genus *Cyon*, as in the subfamilies *Ailurina* and *Procyonina*, and only *one* above and *two* below in *Cynalicus*, which is the number found in the Musteline group. This being the case, on first looking at the imperfect skull of the *Cynalicus* in the British Museum, which unfortunately exhibits only the anterior portion, I was led for a moment to suspect that the true place of this remarkable genus might be among the Weasels, and was the more led to this idea from the circumstance that the animal, in proportions and in colouring, bears a remarkable resemblance to the *Galera barbara*, also an inhabitant of South America; but on more attentive examination I perceived, that not only did the last molar resemble precisely the penultimate in the Dog, but sufficient remained of the skull to show, in the form of the pterygoid appendage, and the presence of the ali-sphenoid canal,

characters decisive against the musteline, and in favour of the canine group. And subsequently Mr. Waterhouse kindly pointed out to me, in that department of the Museum which is entrusted to his care, a fossil cranium from Brazil, which, from being found associated with jaws evidently belonging to that species, is most probably referable to the same, and in this I found that all the characters of the base of the cranium were precisely those of the Dogs.

Although I have not had sufficient opportunities to enable me to offer anything original on the other parts of the anatomy of the Carnivora as bearing upon their classification, perhaps I may be allowed to mention a few known circumstances, which, as they co-exist (so far as is yet known) with the characters which I have pointed out in the three families *Ursidæ*, *Felidæ*, and *Canidæ*, may serve to indicate that the importance I have assigned to those characters is not altogether undeserved. The presence or absence, and the structure of the cæcum have frequently been made use of in determining the limits of groups; and I need but to remind my readers, that in the Weasels, as well as in the Bears and the subursine animals, the cæcum is wanting, and there is little or no distinction between small and large intestine; also that it is in the Cats, in the Hyæna, and the Viverrine section, that this separation is well-marked, and a small or but moderate-sized cæcum is appended. In the Dog, the large intestine is but very little larger than the small intestine, but the separation is marked by a constriction, and by the addition of a cæcum remarkable for the curious manner in which it is several times folded upon itself. There are two other portions of the organization to which I will also allude, as affording characters serving to distinguish the three leading families; and in so doing I take the facts as I find them in the 'Leçons d'Anatomie Comparée,' stated simply, and evidently without any intention of assigning to them any zoological importance. First, with regard to the accessory glands connected with the generative organs of the male: the vesiculæ seminales are wanting throughout the order, unless it be in the Coati-mondi, which Cuvier mentions among the animals possessing them: this solitary exception, if so it be, seems to require confirmation; unfortunately the only two Coati-mondis it ever fell to my lot to examine were both young females. The prostate is spoken of as forming in the Bear, and in the Otter, the Weasel and other "vermiformes," only a layer more or less thick around the commencement of the urethra, while in the Ichneumon, the Cats, the Dogs, the Hyæna, and the Civets, it is salient, differing however in size and the number of its lobes; and Cowper's glands are wanting in the Bear, the Racoon, the Otter, and other "vermiformes," and also in the Dogs, but exist in the Ichneumon, the Civet, the Hyæna, and in the Cats.

The larynx is an organ whose differences of structure are very likely to afford useful zoological characters when studied with that view. Cuvier, after describing the structure it presents in the Dogs, where the most striking characters seem to be the considerable development of the cuneiform cartilages, their S-like shape, and

their continuity with the borders of the epiglottis, proceeds to point out the differences presented by that of the Cats, and briefly observes, "Le Mangouste et la Civette ont la glotte comme les Chats." He then describes a third variety of structure presented by the Bears, and mentions differences in the Racoon, the Badger, the Marten, the Otter, and the Coati, consisting merely of variations presented by the chordæ vocales, and in some the superaddition of sinuses, doubtless only adaptive modifications to the different kinds of voice.

In the foregoing observations nothing has been remarked with reference to the Seals, nor indeed is it absolutely necessary; for the limits of a group, so distinctly marked and peculiarly modified, are never at all likely to be mistaken; but as this singular family is truly and essentially a portion of the order whose arrangement it is here my endeavour to elucidate, a few observations upon them may seem a little called for. Naturalists have long been accustomed to separate from the rest those which are distinguished externally by the presence of the small external ear, and the long riband-like processes of skin projecting from the toes of the hind-feet. These genera, *Otaria* and *Arctocephalus*, are also in their cranial characters the most distinctly separable from the rest, through which, with the exception of the Walrus, a great uniformity prevails, so that a mention of the characters in which the common Seal differs from those having external ears may perhaps suffice. Here there is no trace of a postorbital process, nor of an ali-sphenoid canal; the mastoid can scarcely be said to constitute a process; it is swollen, and appears to form a portion of the auditory bulla, more or less connected with the tympanic portion, from which it is separated by a depressed groove running from the stylo-mastoid foramen backwards and a little inwards. The paroccipital process is never large in any of the family, but it is always distinctly developed, and salient backwards. The Arctocephaline group are distinguished at once by their having a distinct postorbital process and an ali-sphenoid canal; the mastoid projects as a strong process, and seems, as it were, to stand aloof from the auditory bulla, which is small and rounded. The carotid canal has precisely the same course as that pointed out in the Bears and Dogs, while in the common Seal it enters rather more forward, and does not show itself again externally. The *Arctocephalina* have the orbito-sphenoids much compressed together anteriorly to the optic foramina, which almost appear to have coalesced into one: they are also remarkable for the strong development of a process on the anterior part of the rim of the orbit; this however will not well serve as a character, since it is apparent, though in a much less degree, in some of the larger species of the ordinary type, as the *Stenoryhnchus leptonyx*. The Walrus is a peculiar form which I should deem it advisable to constitute a distinct subfamily, since I cannot concur with Mr. Gray in associating with it the *Halichærus gryphus*, whose skull presents all the characters of the true Seals, the elevation in the nasal portion having no relation whatever with the immensely swollen upper jaw of the Walrus, which is necessitated by the enormous size of the canine teeth: in this animal there is no postorbital

process, but that on the anterior rim of the orbit is very strongly developed; there is also an ali-sphenoid canal whose outer wall is very thick; the mastoid is a large thick process, projecting very much as in *Arctocephalus*, but its surface is for the most part continuous with that of the flattened auditory bulla.

If we adopt all the five subfamilies into which this family is divided in the list published by Mr. Gray, the Walrus, and the Arctocephaline group, which differ so decidedly from the other Seals, would almost seem entitled to the rank of families; but rather than so completely dismember such a well-marked group as that of the Seals, I should feel disposed to assign to the differences of the teeth no more than a generic value, and to restrict the number of subfamilies to three,—the *Phocina*, *Trichecina*, and *Arctocephalina*, including in the latter the genera *Otaria* and *Arctocephalus*, the Walrus alone constituting the *Trichecina*, and all the other Seals falling under the first-named section.

I cannot conclude without offering some apology for the length of my communication, more particularly as the number of minute details of form alluded to may render it a little tedious, and among the facts enumerated the number is so small that possess any claim to be considered new; but if I have to any extent succeeded in placing in a clearer light the mutual affinities of the different genera of Carnivora, a subject of which I think all will admit the difficulty, or if I have but brought into its due importance any character, however small, which may render the determination of a fragment more easy to the palæontologist,—if I have achieved but a very small share in the important task of elucidating those real affinities existing throughout nature, which must, when completely made out, render classification not a mere alphabet of reference for the determination of species, but a key to higher generalizations, I trust that my labours have not been thrown away, and that my apparent prolixity may be overlooked.

In offering the annexed synopsis with a view to render the arrangement I would propose more readily comprehensible, I must observe, first, that the lists of genera include only those whose crania I have examined, and therefore I must not be considered as rejecting any that I have omitted, nor do I pledge myself to adopt all that are inserted. Secondly, that the difficulty of expressing in a manner sufficiently decided, and at the same time sufficiently brief for a synoptical form, the characters I have made use of, has compelled me to omit some of them. In order to place the Herpestine genera of the Viverrine subfamily in juxtaposition with the Weasel group, it is advisable that the series of terrestrial Carnivora should either commence with the Bears and terminate with the Dogs, or *vice versa*; and as I have not seen in the Seals anything which, in my opinion, warrants their approximation to any of the other families more than to another, it matters little which mode be followed.

Fam. URSIDÆ.

Auditory bulla rising suddenly on its inner side, and more or less flattened off towards the meatus.

Paroccipital process prominent, and neither flattened on the surface of the auditory bulla, nor laterally compressed.

Foramen condyloideum exposed. A considerable foramen glenoideum.

No cæcum. No Cowper's glands.

Prostate gland not salient, being contained in the thickened walls of the urethra.

Subfam. URSINA. (Of general geographical distribution.)

A distinct ali-sphenoid canal.

Internal carotid artery reappearing externally after passing through its canal, and doubling back to enter the cranium.

True molars on each side $\frac{2}{3}$.

Ursus (including the subgenera).

Subfam. AILURINA. (Confined to India.)

A distinct ali-sphenoid canal.

True molars on each side $\frac{2}{2}$.

Ailurus.

Subfam. PROCYONINA. (Confined to America.)

No ali-sphenoid canal.

True molars on each side $\frac{2}{2}$.

Procyon.

Nasua.

Cercoleptes.

Bassaris.

Subfam. MUSTELINA. (Of general geographical distribution.)

No ali-sphenoid canal.

True molars on each side $\frac{1}{2}$.

Arctonyx.

Meles.

Taxidea.

Mydaus.

Mephitis.

Gulo.

Helictis.

Mellivora.

Grisonia.

Galera.

Vison.

Mustela.

Martes.

—

Lutra.

Fam. FELIDÆ.

Auditory bulla rounded, frequently showing indications of being divided into two parts.

Paroccipital process flattened, and applied to the back part of the auditory bulla.

Foramen condyloideum more or less concealed. Foramen glenoideum very small or wanting.

Cæcum small or moderate, simple. Cowper's glands present. Prostate gland salient.

Subfam. VIVERRINA. (Confined to the old world.)

A distinct ali-sphenoid canal (with very few exceptions*).

Auditory bulla distinctly subdivided.

Canalis caroticus distinct, though sometimes only as a groove.

True molars on each side $\frac{2}{2}$.

Galictis.

Ryzæna.

Cynictis.

Herpestes.

—

Arctictis.

Cynogale.

Paradoxurus.

—

Prionodon.

Genetta.

Viverra.

Subfam. HYÆNINA. (Confined to the old world.)

No ali-sphenoid canal.

Division of auditory bulla scarcely perceptible.

Canalis caroticus indistinct, or very small.

True molars on each side $\frac{1 \text{ or } 0}{1}$; premolars on each side $\frac{4}{3}$.

Proteles.

Hyæna.

Subfam. FELINA. (Of general geographical distribution.)

No ali-sphenoid canal.

Division of auditory bulla slightly, or scarcely perceptible.

Canalis caroticus indistinct, or not perceptible.

True molars on each side $\frac{1}{1}$; premolars on each side $\frac{3}{2}$.

Felis.

Fam. CANIDÆ.

A distinct ali-sphenoid canal. A considerable foramen glenoideum.

Auditory bulla rounded, not divided.

Internal carotid artery reappearing externally after passing through its canal, and doubling back to enter the cranium.

Paroccipital process laterally compressed, foramen condyloideum exposed.

Cæcum folded upon itself. No Cowper's glands. Prostate gland salient.

Cynalicus.

Cyon.

Lycaon.

Canis.

Vulpes.

Nyctereutes.

Otocyon.

* The exceptions that I have seen are the Rasse (*Viverra malaccensis*) and a species of *Galictis*.

Fam. PHOCIDÆ.

Molars all similar in structure. (The general characters need not here be enumerated, being universally known.)

Subfam. ARCTOCEPHALINA.

A postorbital process. An ali-sphenoid canal.

Mastoid process strong and salient, standing aloof from the auditory bulla.

Otaria.

Arctocephalus.

Subfam. TRICHECINA.

No postorbital process. A distinct ali-sphenoid canal.

Mastoid process strong and salient, its surface continuous with the auditory bulla.

Trichecus.

Subfam. PHOCINA.

No postorbital process. No ali-sphenoid canal.

Mastoid process swollen, and seeming to form part of the auditory bulla.

Morunga.

Cystophora.

Halichærus.

Ommatophora.

Lobodon.

Leptonyx.

Stenorhynchus.

Phoca.

ROYAL SOCIETY.

Jan. 18, 1849.—“On the Development and Homologies of the Carapace and Plastron of the Chelonian Reptiles.” By Professor Owen, F.R.S.

The author commences by defining the several parts of which the osseous thoracic-abdominal case of the Chelonian Reptiles is composed, and briefly discusses the several opinions that have been published with regard to their nature and homologies, dwelling chiefly on that recently proposed by Prof. Ratlike, in his work on the Development of the *Chelonia*, in which it is contended that the carapace consists exclusively of the development of parts of the endo-skeleton, viz. the neural spines and vertebral ribs (*pleurapophyses*), agreeably with the opinion of CUVIER and BOJANUS, and that the remainder of the thoracic-abdominal case, consisting of the “marginal pieces” and “plastron,” are formed entirely from bones of the dermal system.

Adverting to the hypotheses of Cuvier, Geoffroy and Meckel, that the thoracic-abdominal case is a modification of parts of the endo-skeleton exclusively, the author tests their determinations by comparisons with the corresponding parts of the bird and crocodile, and infers, from the latter animal, that the hyosternal, hyposternal and xiphisternal bones are not parts of the sternum, but are homologous with the hæmapophyses (sternal ribs and abdominal ribs); those in the